DISCUSSION

This map shows areas of relative landslide hazard for natural slopes under static (non-earthquake) conditions and indicates where further study is recommended prior to development (see table in map explanation). Areas of artificial fill, such as dam embankments and mine waste dumps, were not evaluated. The map is one of four sheets that cover the western Wasatch County study area (see "Location Map and Index to Sheets" at bottom of map).

Landslides, rock falls, and debris flows are downslope movements of rock or soil under the influence of gravity. Landsliding, characterized by rotational or translational movement along a buried slip surface, has been one of the most damaging geologic hazards in western Wasatch County. Some landslides are deep-seated and move slowly over long periods of time, whereas others are shallow and move rapidly in a single event. Landslides can damage buildings, transportation routes, and utilities both directly from ground displacement and indirectly from associated flooding. Avoidance is one prudent measure for landslide-hazard reduction, but engineering techniques are available to stabilize slopes and ensure that site grading and development do not destabilize slopes.

Rock-fall and debris-flow hazards are related to landslide hazards, but are not shown on this map. Rock falls generally have not been a significant hazard in most of western Wasatch County because of a lack of source areas. However, rock falls may occur locally below steep rock exposures such as road cuts, cliffs, or stream banks, and may be especially numerous during strong ground shaking accompanying earthquakes. Debris-flow hazard areas are discussed and shown on another set of maps in this folio (Flood Hazards, Earthquake Hazards, and Problem Soils, plates 2A through 2D).

Slope steepness is a primary factor in determining landslide susceptibility. However, several other factors influence landslide susceptibility and can result in some gentle slopes being more susceptible to landsliding than steeper slopes. These factors include: (1) depth to ground water and changes in ground-water conditions; (2) the presence of springs or concentrated surface water; (3) active stream incision, bank erosion, or undercutting; (4) the orientation of planar features such as bedding, joints, faults, or the bedrock-soil interface; and (5) the strength of the rock or soil. Rock units containing low-strength, moisture-sensitive shale or clay are typically the most susceptible to landsliding, as are silty or clayey unconsolidated deposits. Development can increase the potential for landsliding if careful consideration is not given to structure design and siting, grading and other slope modifications, and increased ground moisture from on-site wastewater disposal and landscape irrigation.

Many of the landslides in western Wasatch County occurred during Pleistocene time (1.6 million to 10,000 years ago). The Pleistocene climate in Utah was wetter than the modern climate, and elevated pore-water pressures in the soil and rock contributed to landsliding. Although some of the slopes that failed during Pleistocene time may be relatively stable now, old landslides can be particularly susceptible to reactivation because of conditions such as increased permeability in the displaced soil or rock mass and established failure planes.

USE OF THIS MAP

The relative landslide hazard shown on this map consists of three categories: low, moderate, and high. The criteria used to define the relative landslide hazard were developed from analyzing failed geologic units, slope inclinations, and ages of existing landslides. A critical slope value was assigned for each geologic unit representing the inclination above which slope failure has typically occurred in the past. The more susceptible the geologic unit is to landsliding, the lower the critical slope value. The critical slope-inclination values used to derive the relative-hazard zones on this map range from 15 percent (9 degrees) to 50 percent (27 degrees). To incorporate existing landslides into the hazard rating, emphasis was placed on landslides estimated to have occurred during the past 5,000 years (late Holocene time) because these landslides represent slope failures under climatic conditions similar to the present. The map shows existing landslides identified in this study from geologic mapping, aerial-photograph interpretation, review of existing geological and geotechnical reports, and field reconnaissance. Existing landslides of late Holocene age (young) are designated on the map with a "Y." Existing landslides of pre-late Holocene age (old) are designated with an "O."

A low landslide hazard exists where slope inclination is less than the selected critical value and there is no evidence of previous landsliding (map unit L). Except in the case of essential facilities (for example, police and fire stations), site-specific geotechnical studies of landslide hazard will usually not be warranted prior to permitting development on sites within map unit L.

A moderate landslide hazard exists where slope inclination is greater than the selected critical value and there is no evidence of previous landsliding (map unit M), and where slope inclination is less than the selected critical value but there is evidence of previous landsliding (map units M_Y and M_O). Site-specific, reconnaissance-level geotechnical studies of landslide hazard are recommended prior to permitting development on sites within map units M, M_Y and M_O. Depending on the results of the reconnaissance-level study, some sites may require a detailed, quantitative slope-stability analysis to adequately evaluate the hazard and develop hazard-reduction measures.

A high landslide hazard exists where slope inclination is greater than the selected critical value and there is evidence of previous landsliding (map units H_Y and H_O). Site-specific, reconnaissance-level studies may in some cases be adequate to evaluate the hazard on sites within map units H_Y and H_O. However, detailed, quantitative slope-stability analyses will likely be necessary to evaluate the hazard and develop hazard-reduction measures prior to development within these high-hazard areas.

Existing landslides were mapped outside of the study-area boundary. These landslides are designated with either a "Y" or an "O" for reference, but do not include a relative-hazard designation as the hazard was not evaluated outside of the study area.

This map is intended to be used as a tool for planning new development. It will be most effective if used early in the planning process to identify the potential need for landslide-hazard studies on a development-wide scale. In existing residential developments within moderate- and high-hazard areas, site-specific hazard studies are recommended prior to new construction. Cooperatively funded studies of subdivisions or groups of lots may be the most cost-effective means of hazard evaluation in large areas of moderate or high hazard.

This map is at a regional scale and the map-unit boundaries are approximate. Although the map can be used to gain an understanding of the potential for landslides in a given area, it is not designed to replace site-specific studies performed by qualified professionals (engineering geologists, geotechnical engineers) to evaluate the hazard and, if necessary, recommend hazard-reduction measures. Because of the relatively small scale of the map, the possibility exists that some small moderate- and high-hazard areas are not shown. Studies are therefore recommended for essential facilities even in low-hazard areas.

EXPLANATION

Main scarp of landslide

y, o — Landslide deposit
y, late Holocene (young)
o, pre-late Holocene (old)

L, M, H — Relative landslide hazard, based on geologic unit, topographic slope, and existing landslides (see table below)

F — Artificial fill (landslide hazard not evaluated)

MAP UNIT	RELATIVE HAZARD	RECOMMENDED SITE-SPECIFIC STUDIES
L	Low	None (except for essential facilities, where recommendations for moderate hazard apply)
M, M_y, M_o	Moderate	Reconnaissance-level geotechnical hazard evaluation; quantitative slope-stability analysis may be necessary
H_y, H_o	High	Reconnaissance-level geotechnical hazard evaluation; detailed slope-stability analysis likely necessary

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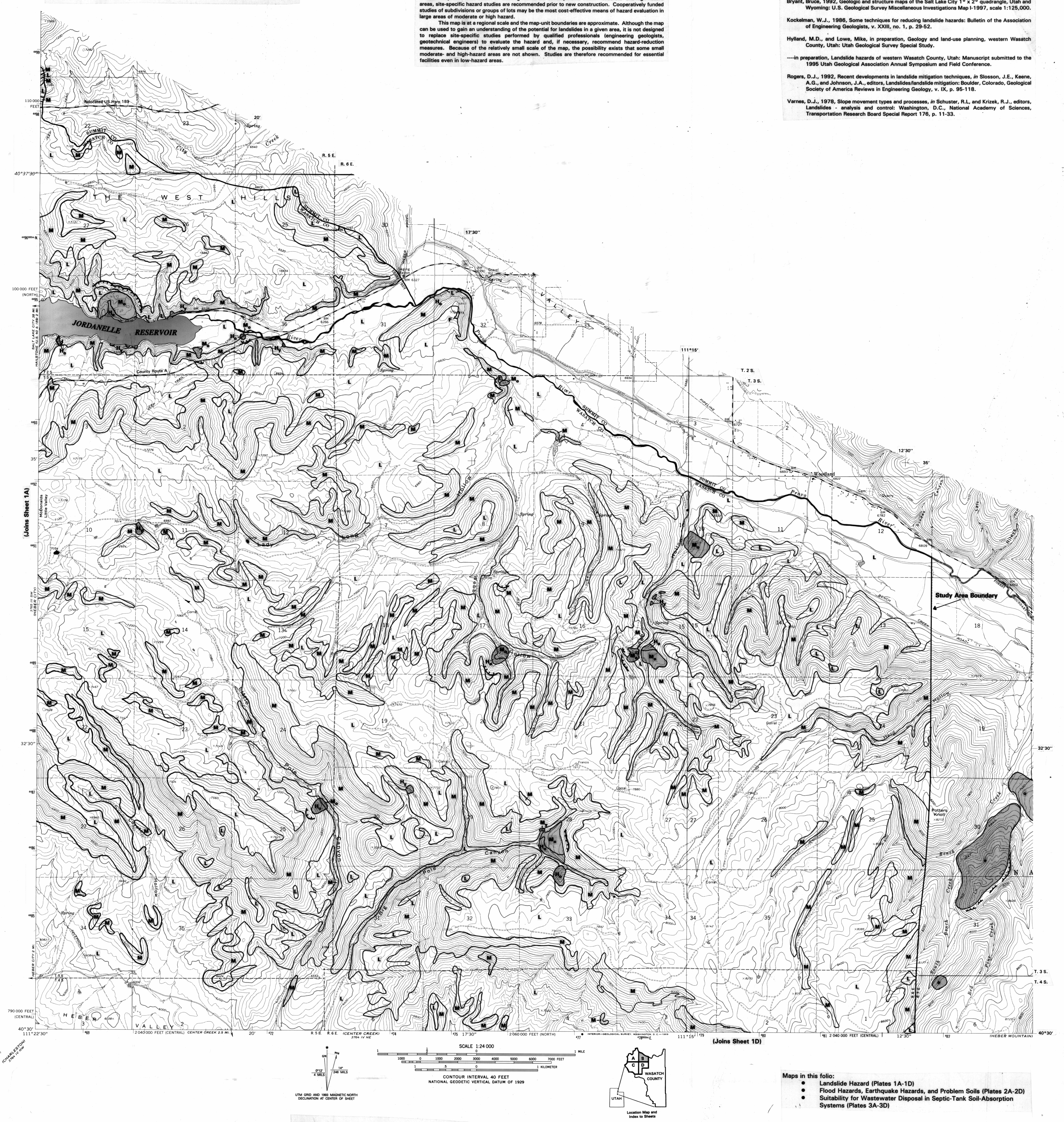
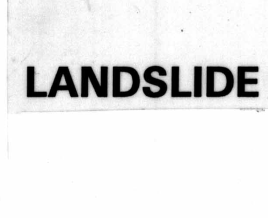
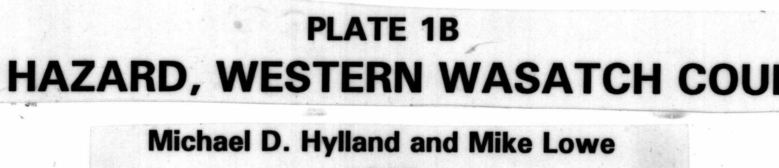
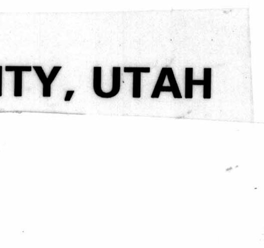




UTM GRID AND 1993 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



Location Map and Index to Sheets

Maps in this folio:
- Landslide Hazard (Plates 1A-1D)
- Flood Hazards, Earthquake Hazards, and Problem Soils (Plates 2A-2D)
- Suitability for Wastewater Disposal in Septic-Tank Soil-Absorption Systems (Plates 3A-3D)

Base from Kamas, Francis, and Woodland, Utah, USGS 7.5-minute topographic quadrangle maps.
Drafted by Noah P. Snyder

PLATE 1B
LANDSLIDE HAZARD, WESTERN WASATCH COUNTY, UTAH

Michael D. Hylland and Mike Lowe

1995